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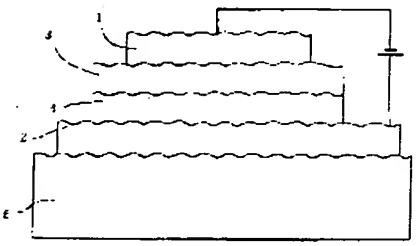
(54) ORGANIC EL ELEMENT

(57)Abstract:
PURPOSE: To average the interference effect, and to reduce a visual angle dependent property and a membranous thickness dependent property. by laminating an organic electroluminescence(EL) layer and a metallic electrode, and making the surface contacting to either the EL layer or the metallic electrode in a rough surface.
CONSTITUTION: A transparent electrode 2, an organic EL layer 3, and a metallic electrode 1 are laminated on a transparent base 6 in this order. In this case, the surface of the base 6 is made in a rough surface by a corrosion-processing with a medicine having a corrosive function such as a fluorate, or by sandblasting. Then, on the rough surface of the base 6, the layer of the transparent electrode 2 is formed by a spattering. After the electrode is formed, a TPD and an AIq3 are evaporated in order by a resistance-heating evaporation in a vacuum ambiance, so as to form the metallic electrode 1. As a result, the path differences of luminous points in the luminous layer 3 observed from the visual angle are different, and the interference effect is averaged. Consequently, the visual angle dependent property of the brightness and the luminous spectrum, and the variation owing to the uneven membranous thickness can be suppressed.



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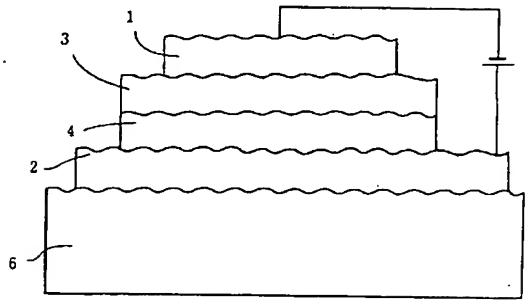
Drawing selection [Representative drawing]



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* NOTICES *

DETAILED DESCRIPTION

[Detailed Description of the Invention]
[0001]
[Industrial Application] this invention relates to the organic EL element especially whose photogene is an organic compound about the EL element equipped with EL layer which formed this matter in the thin film using the electroluminescence (henceforth EL) of the matter by pouring of current.
[0002]
[Description of the Prior Art] As shown in drawing 3 , as this kind of an organic EL element between the metal cathode 1 and the transparent anode plate 2 As shown in the thing of the two-layer structure where the EL layer 3 which consists of an emitter thin film by which consisted of an organic compound, respectively and the laminating was carried out mutually, and the electron hole transporting bed 4 were allotted, and drawing 4 The thing of the three-tiered structure to which the electronic transporting bed 5 and the EL layer 3 which consist of an organic compound by which the laminating was carried out between the metal cathode 1 and the transparent anode plate 2, and the electron hole transporting bed 4 were allotted is known. Here, the electron hole transporting bed 4 has the function carried out that it is easy to make an electron hole pour in from an anode plate, and the function which blocks an electron, and the electronic transporting bed 5 has the function carried out that it is easy to make an electron pour in from cathode, and the function which blocks an electron hole.
[0003] For example, the work function of aluminum, magnesium, an indium, silver, or each alloy becomes the metal cathode 1 from a small metal, and that whose thickness is about 1000-5000A can use for it. moreover -- from a conductive material with big work functions, such as an indium stannic-acid ghost (henceforth ITO), to an anode plate 2 -- becoming -- thickness -- about 1000-3000A -- or that whose thickness is about 800-1500A can use withgold
[0004] An aluminum quinolinol complex (henceforth Alq3), i.e., aluminum oxine chelate, a tetrapod phenyl butadiene derivative, etc. may be used for the EL layer 3. N, N'-diphenyl which are a triphenyl diamine derivative at the electron hole transporting bed 4 - N, the N'-screw (3 methylphenyl) -1, the 1'-biphenyl -4, and a 4'-diamine (henceforth TPD) are used preferably, and can use the compound further known as coal tar mixture (Carrier Transporting Materials) as independence or mixture.
[0005] For example, an OKISA diazole derivative (PBD) etc. may be used for electronic ******. In these organic EL element, the glass substrate 6 is arranged on the outside of a transparent electrode 2. An exciton arises by the reunion of the electron poured in from the metal cathode 1, and the electron hole poured in from the transparent anode plate 2 in the EL layer 3. Light is emitted in the process in which an exciton carries out radiation deactivation near the interface with the electron hole transporting bed in EL layer, and this light is emitted outside through the transparent anode plate 2 and a glass substrate 6 (refer to JP,59-194393,A and a JP,63-295695,A official report).
[0006]
[Problem(s) to be Solved by the Invention] By the way, the artificer did the knowledge of there being the dependency and the degree dependency of viewing angle by EL layer thickness to brightness as a result of research of EL layer thickness of the organic EL element of two-layer

structure, an emission spectrum, brightness, and the degree of viewing angle. That is, an emission spectrum and brightness change with the angles as which a viewer regards the glass-substrate 6 side front face of an organic EL element as shown in drawing 5 .

[0007] Two light of Path B which reflects in the light emitted from one point of the source P of luminescence in EL layer by the path A which goes to the direct substrate 6 in drawing, and the metal electrode 1 on the back, and goes to a substrate 6 for a viewer is contained. Since the light of these two paths holds the optical path difference L shown in the following formulas 1, and phase contrast [which is further shown in a formula 2] etay, it interferes mutually (lambda shows wavelength for the viewing angle to which y swerves [distance / from the source P of luminescence to a metal electrode 1 / theta] from the refractive index of the EL layer 3 from the normal on the front face of a display in EL layer as for n among both formulas, respectively.). Hereafter, it is the same.

[0008]

[Equation 1]

$$L=2ny\cos\theta$$

[0009]

[Equation 2]

$$\frac{4\pi ny\cos\theta}{\lambda}=\eta y$$

Therefore, the intensity I (y, lambda) can be expressed like a formula 3 as an interference effect.

[0010]

[Equation 3]

$$I(y,\lambda)=\frac{1}{2}\{1+\cos(\eta y)\}$$

[0011] In EL layer, a luminescence on-the-strength f (y) distribution can decrease, so that it goes to a metal electrode 1 strongly in the interface of the electron hole transporting bed 4, as shown in drawing 6 , it can be expressed like a formula 4 as an exponential distribution about thickness, and can be normalized like a formula 5 as the whole EL layer (epsilon shows a luminescence intensity-distribution parameter and, as for k, the inside of both formulas and d show a constant for the distance from the source of luminescence to a metal electrode, respectively. Hereafter, it is the same.

[0012]

[Equation 4]

$$f(y)=k\exp(y/\varepsilon)$$

[0013]

[Equation 5]

$$\int_{-\infty}^{d} f(y)\,dy=1$$

[0014] The intensity distribution F of the emission spectrum of the source of luminescence itself (lambda) can be expressed as a function of the wavelength lambda peculiar to an emitter. Therefore, the luminescence intensity T of the EL element actually observed by the viewer (lambda, theta, d) can be expressed like a formula 6.

[0015]

[Equation 6]

$$T(\lambda)=F(\lambda)\times\int_{0}^{d} f(y)\times I(y,\lambda)\,dy$$

[0016] Alq3 which made thickness d 6000A here in order to check the luminescence intensity T of

an EL element (lambda, theta, d) from -- the organic EL element containing becoming EL layer was created, the viewing angle theta was variously changed from 0 degree to 75 degrees, and the luminescence intensity was examined Drawing 7 shows the luminescence intensity distribution to luminescence wavelength. It was checked that the luminescence intensity T of this luminescence intensity distribution and above-mentioned formula 6 (lambda, theta, d) carries out abbreviation coincidence. For a viewer, color seems to differ one by one by the direction which looks at the EL-element screen from the viewing angle of 0 degree to 75 degrees so that clearly from drawing.
[0017] Furthermore, the visibility property E of the viewer who responds with a specific value to wavelength lambda, or a light sensitive cell (lambda) is taken into consideration so that practical use may be met. For example, when the visibility property E (lambda) is made into a normal distribution, brightness property [of the EL element within this sensitivity property] L (d) can be expressed as a function of d like a formula 7 (K shows a constant).
[0018]
[Equation 7]

$$L(d)=K\int_{0}^{\infty}T(\lambda)\times E(\lambda)\,d\lambda$$

[0019] drawing 8 -- Alq3 from -- the thickness brightness attenuation (property) of brightness/current characteristic to the thickness at the time of changing the thickness ranging from 0A of abbreviation to 8000A about becoming EL layer (theta= 0, n= 1.7), and calculating is shown, and this decay curve shows the thickness dependency of the brightness in an organic EL element
[0020] A color and brightness change from the above thing at the angle which will look at an organic EL element if color display is performed, since a color (emission spectrum) and brightness change with viewing angles and brightness changes with the variations in thickness, it becomes very inconvenient as a display, and the improvement serves as a big technical problem.
[0021] Then, this invention aims at offering the organic EL element which coped with such a situation, was made and reduced brightness and the viewing-angle dependency of an emission spectrum.
[0022]
[Means for Solving the Problem] this invention is characterized by being completed based on the above-mentioned knowledge and split-face-izing the field of the side which touches the aforementioned organic EL layer of the field of the side which touches the aforementioned metal electrode of the aforementioned organic EL layer, or the aforementioned metal electrode in the organic EL element which carried out the laminating of a transparent electrode, organic EL layer, and the metal electrode to order on the transparent substrate.
[0023]
[Function] With the field luminescence equipment of this invention, if it was in organic EL layer which consists of a hole transporting bed and a luminous layer, for example, when brightness changed with thickness and an emission spectrum and brightness changed with viewing angles, it became clear by this invention person's etc. experiment that brightness will fall with a viewing angle. Furthermore, such change made clear what an interference model can explain.
[0024] Therefore, since the optical path difference of the light from the point in a luminous layer emitting light differs somewhat and the interference effect is equalized by split-face-izing the field of the side which touches the field of the side which touches the metal electrode of organic EL layer, or organic EL layer of a metal electrode, angular dependence and a thickness dependency become small.
[0025]
[Example] Hereafter, the detail of the example of this invention is explained based on a drawing. In addition, in drawing explained below, the explanation which gives the same sign to the portion which is common in drawing 3 , and overlaps is omitted.
[0026] what shows one example when drawing 1 applies the organic EL element of this invention to the thing of two-layer structure -- it is -- the split-face top of a glass substrate 6 -- In 2O3 and

SnO2 etc. -- the metal electrode 1 which consists of a luminous layer 3 which consists of the hole transporting bed 4 and aluminum kino RINOMU complex (Alq3) which consist of a triphenyl diamine derivative (TPD) which constitutes a transparent electrode 2 and organic EL layer, Mg-aluminum, etc. is formed in order

[0027] Drawing 2 expands and shows the above-mentioned split-face portion, the greatest height of the split-face-ized field is set to about 1 micrometer, and, as for the interval L of the mountain and mountain which were split-face-ized, being referred to as about 3 micrometers is desirable. And the organic EL element split-face-ized as mentioned above is created as follows.

[0028] First, the front face of a glass substrate 6 is processed, for example by chemical-attack processings, sandblasting processings, etc. with corrosive action, such as fluorine acid chloride. The greatest height of the field split-face-ized at this time and the interval L of a mountain and a mountain are about 1 micrometer and about 3 micrometers, respectively. These arts are the so-called process of frosted glass, and the same technique.

[0029] Subsequently, the layer of the transparent electrode 2 which made the thin film of ITO about 1000A by sputtering is formed on the field where the glass substrate 6 was split-face--ization-processed. In case the layer of this transparent electrode 2 is formed, it is Ar and O2. While using mixed gas, it carries out in the degree of vacuum of about 10 to 3 Torrs.

[0030] It is TPD and Alq3 on the field after finishing formation of a transparent electrode 2 in the degree of vacuum of 10-6 - 10-7Torr. Vacuum evaporationo is carried out to order by the resistance heating vacuum deposition, and the 500A hole transporting bed 4 and a luminous layer 3 are formed, respectively. After finishing formation of a luminous layer 3, on it, the vacuum evaporationo of the Mg-aluminum is carried out in the degree of vacuum of 10-6 - 10-7Torr, and a metal electrode 1 is formed.

[0031] Thus, it will be split-face-ized by the grade which the interface of each class mentioned above. The optical path difference of each point in the luminous layer when seeing from a certain viewing angle emitting light differs, and it becomes consequently, less fixed. Therefore, the interference effect will be equalized and change by brightness and the viewing-angle dependency of an emission spectrum, or the variation of thickness will also be suppressed.

[0032] Since regular reflection furthermore decreases, contrast also improves. In addition, although this example explained the case where the field where ****, a luminous layer, and a metal electrode meet with split-face--ization-processing to the front face of a glass substrate 1 first was split-face-ized, you may be made to perform split-face-ized processing only to the field of the side which touches the metal electrode of not only this example but a luminous layer.

[0033] Furthermore, in the three-tiered structure which shows this invention to not only the two-layer structure of the above-mentioned example but drawing 4 , the interface between each class can be split-face-ized similarly.

[0034]

[Effect of the Invention] Since according to the organic EL element of this invention the interference effect was equalized and angular dependence and the thickness dependency were made small by having split-face-ized the field of the side which touches the field of the side which touches the metal electrode of organic EL layer, or organic EL layer of a metal electrode, and having changed the optical path difference of the light from the point in a luminous layer emitting light as explained above, the fall of the brightness by the viewing angle can be prevented.

[Translation done.]

* NOTICES *

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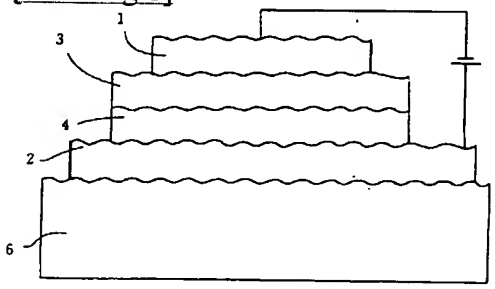
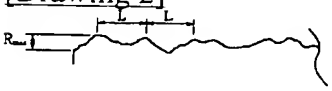
DRAWINGS

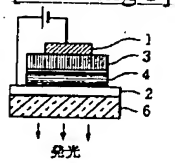
[Drawing 1]



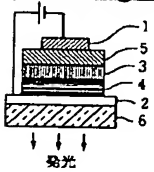
[Drawing 2]



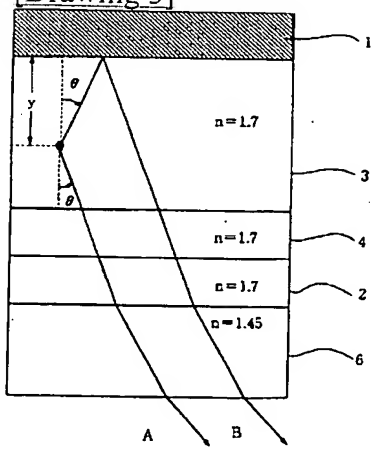
[Drawing 3]



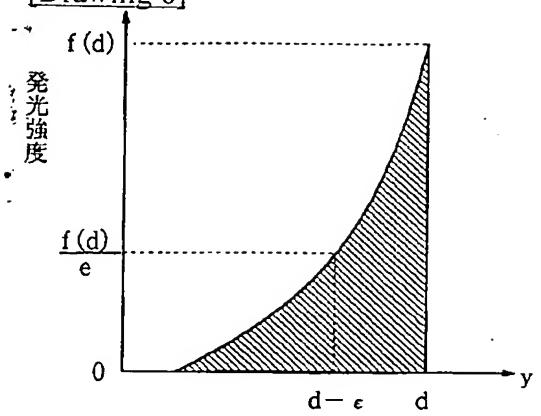
[Drawing 4]



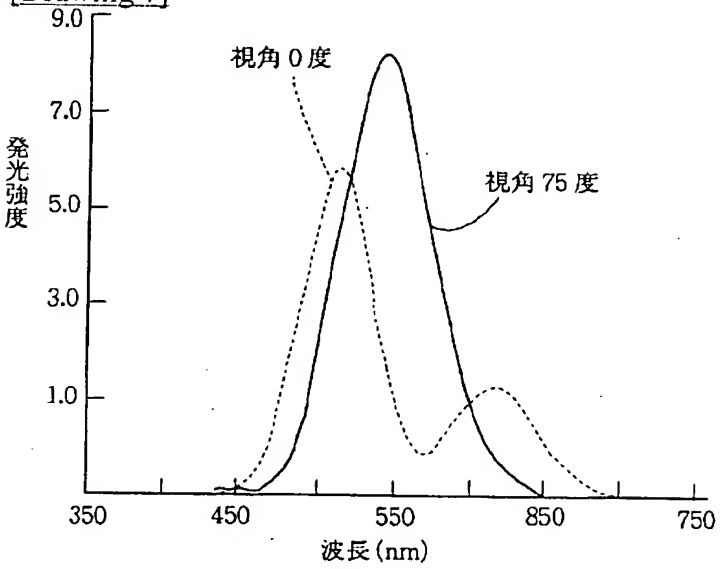
[Drawing 5]



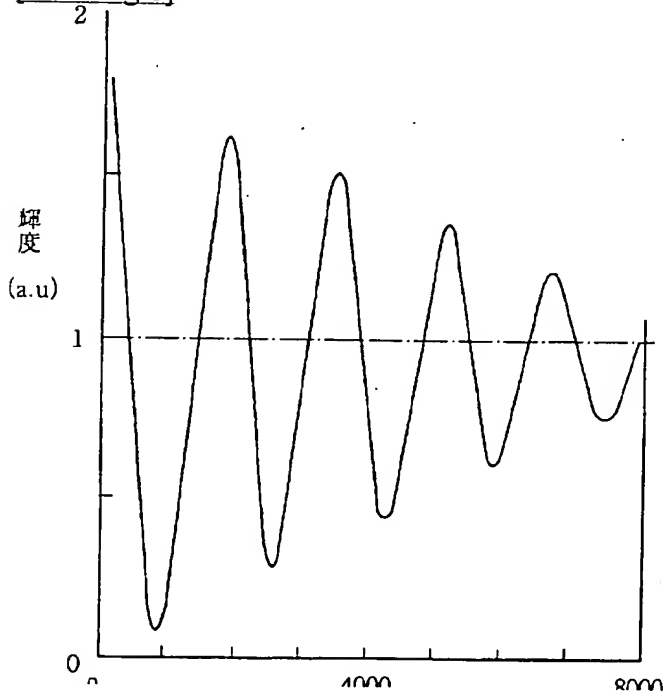
[Drawing 6]



[Drawing 7]



[Drawing 8]



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CLAIMS

[Claim(s)]

[Claim 1] The organic EL element characterized by split-face-izing the field of the side which touches the aforementioned organic EL layer of the field of the side which touches the aforementioned metal electrode of the aforementioned organic EL layer, or the aforementioned metal electrode in the organic EL element which carried out the laminating of a transparent electrode, organic EL layer, and the metal electrode on the transparent substrate at order.

[Translation done.]